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Enumeration and Coded-Wire Tagging of Coho Salmon *(Oncorhynchus kisutch)* Smolts Leaving Black Creek, Vancouver Island, During 1978 and 1979, Their Subsequent Distribution in Sport and Commercial Fisheries, and Escapement to the Creek in 1978-1980

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ENUMERATION AND CODED-WIRE TAGGING OF COHO SALMON (*Oncorhynchus kisutch*) SMOLTS LEAVING BLACK CREEK, VANCOUVER ISLAND, DURING 1978 AND 1979, THEIR SUBSEQUENT DISTRIBUTION IN SPORT AND COMMERCIAL FISHERIES, AND ESCAPEMENT TO THE CREEK IN 1978-1980

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ABSTRACT

Clark, D. G. and J. R. Irvine. 1989. Enumeration and coded-wire tagging of coho salmon (Oncorhynchus kisutch) smolts leaving Black Creek, Vancouver Island, during 1978 and 1979, their subsequent distribution in sport and commercial fisheries, and escapement to the creek in 1978-1980. Can. MS Rep. Fish. Aquat. Sci. 2017: 45 p.

Coho salmon smolts leaving Black Creek during the spring of 1978 and 1979 were enumerated and had coded-wire tags inserted in them. In 1978 and 1979 respectively, 46,405 and 46,566 coho smolts were counted through the trap. In 1978, 30,370, 1976 brood coho were adipose fin clipped and coded-wire nose-tagged, and in 1979, 40,013, 1977 brood smolts were clipped and tagged. Approximately 29,906 tagged smolts were released in 1978 and 39,376 in 1979. During the fall of 1978, 1979, and 1980, and adult enumeration fence was operated. Coho escapement counts were estimated in 1978, 1979, and 1980 to be 8391, 1368, and 3134 fish respectively. Results from the mark recovery program indicate that the sport fishery in the Strait of Georgia caught the largest portion of the catch (41%). The total estimated sport and commercial catch of coho from Black Creek was 8793 for the 1976 brood and 9099 for the 1977 brood. The catch to escapement ratio for the 1976 brood was calculated to be 6.4:1, and for the 1977 brood, 3.6:1. The estimated survival of 1976 brood smolts to adults was 21.4%; and of 1977 brood smolts 23.9%. Results indicate that natural streams can maintain populations of coho salmon without hatchery smolt releases or enhancement in spite of moderately heavy exploitation pressures, provided that instream habitat is adequate to permit high production and survival of smolts.

RÉSUMÉ

Clark, D. G. and J. R. Irvine. 1989. Enumeration and coded-wire tagging of coho salmon (Oncorhynchus kisutch) smolts leaving Black Creek, Vancouver Island, during 1978 and 1979, their subsequent distribution in sport and commercial fisheries, and escapement to the creek in 1978-1980. Can. MS Rep. Fish. Aquat. Sci. 2017: 45 p.

Des saumonneaux coho partis de Black Creek aux printemps 1978 et 1979 one été dénombrés et étiquetés de micromarques magnétisées codées. En 1978 et 1979 respectivement, 46 405 et 46 566 saumonneaux coho sont passés par la porte de contrôle. En 1978, on a coupé la nageoire adipeuse et posé des micromarques magnétiques codées dans le nez de 30 370 coho géniteurs; en 1979, on a coupé et étiqueté 40 013 saumonneaux géniteurs de 1977. On a mis en liberté environ 29 906 saumonneaux étiquetés en 1978 et 39 376 en 1979. A l'automne des années 1978, 1979 et 1980, on a mis en marche une clôture servant au dénombrement des adultes. Le nombre de coho qui se sont échappés en 1978, 1979 et 1980 a été estimé à 8391, 1368 et 3134 respectivement. Selon les résultats obtenus dans le cadre du programme de reprise de poissons étiquetés, la plus grande partie des poissons (41%) auraient été attrapés par des amateurs de pêche sportive dans le détroit de Georgia. Le total des prises de coho en provenance de Black Creek pour les pêches sportive et commerciale a été estimé à 8793 pour les géniteurs de 1976 et à 9099 pour ceux de 1977. Pour les géniteurs de 1976, le taux des prises par rapport aux échappées était de 6.4:1 et de 3.6:1 pour les géniteurs de 1977. On estimé à 21.4 et 23.9 les pourcentages de saumonneaux géniteurs parvenus à l'âge adulte pour 1976 et 1977 respectivement. Les résultats démontrent que les saumons coho peuvent survivre dans des cours d'eau naturels sans que des saumonneaux de frayère ne soient lâchés ni que les stocks ne soient mis en valeur, malgré les pressions exercées par une exploitation modérée et en autant que l'habitat des cours d'eau puisse permettre une reproduction abondante de saumonneaux et assurer leur survie.

INTRODUCTION

Management of British Columbia's salmon fishery is hampered by a lack of accurate, long-term information on smolt production, catch distribution and escapement returns for individual stocks. This is especially true for coho salmon (Oncorhynchus kisutch), partly because of the importance of small streams in their life cycle, and the costs associated with monitoring smolt production and adult returns to many small streams.

Accurate escapement estimates improve our ability to evaluate fishery management actions. Additional information on migration timing, catch distributions, and harvest and survival rates can help fishery managers establish escapement goals for individual stocks. This kind of information is available for some hatchery stocks and is often used to develop management plans for wild stocks in the same area. Rarely is there similar information for wild stocks of coho salmon.

Because it is not practical to monitor the smolt production and escapements of many small coho-producing streams, an approach that is being evaluated in British Columbia is to monitor steams that may be representative of others in the same geographical area. Stream or escapement indexing uses estimates of escapements in an index stream to predict escapements in nearby and similar streams (Waldichuk 1984). A key stream is a significant salmon producer that may be representative of other nearby streams.

Black Creek has been designated a key stream for wild coho salmon populations on the east coast of Vancouver Island. Hamilton (1978) studied the fish habitat in Black Creek and investigated the relationship between land use, fish production and escapement. Our report summarizes studies conducted on Black Creek between 1978 and 1980 when two smolt runs were enumerated and tagged with coded-wire nose tags (1978 and 1979) and three escapement runs were enumerated (1978, 1979, and 1980). This work was performed to evaluate the productivity and contribution of wild stocks prior to major fish production facilities being established as fisheries enhancement efforts by the Department of Fisheries and Oceans. The studies were done under the authority of the Georgia-Johnstone Strait Headwater Tagging Program. Results are being published to provide a baseline for comparison with subsequent studies and to help evaluate the usefulness of the key streams approach to salmon management.

STUDY AREA

Black Creek is a major coho-producing stream on the east coast of Vancouver Island (Figure 1), located between the Oyster River and the Tsolum River. The Black Creek watershed contains a series of swamps and small lakes, the largest being Northy Lake. Much of the swamp area downstream from Northy Lake has been altered to increase runoff in the early spring to allow for agricultural development. Miller Creek, a tributary that flows into Northy Lake, is relatively undeveloped.

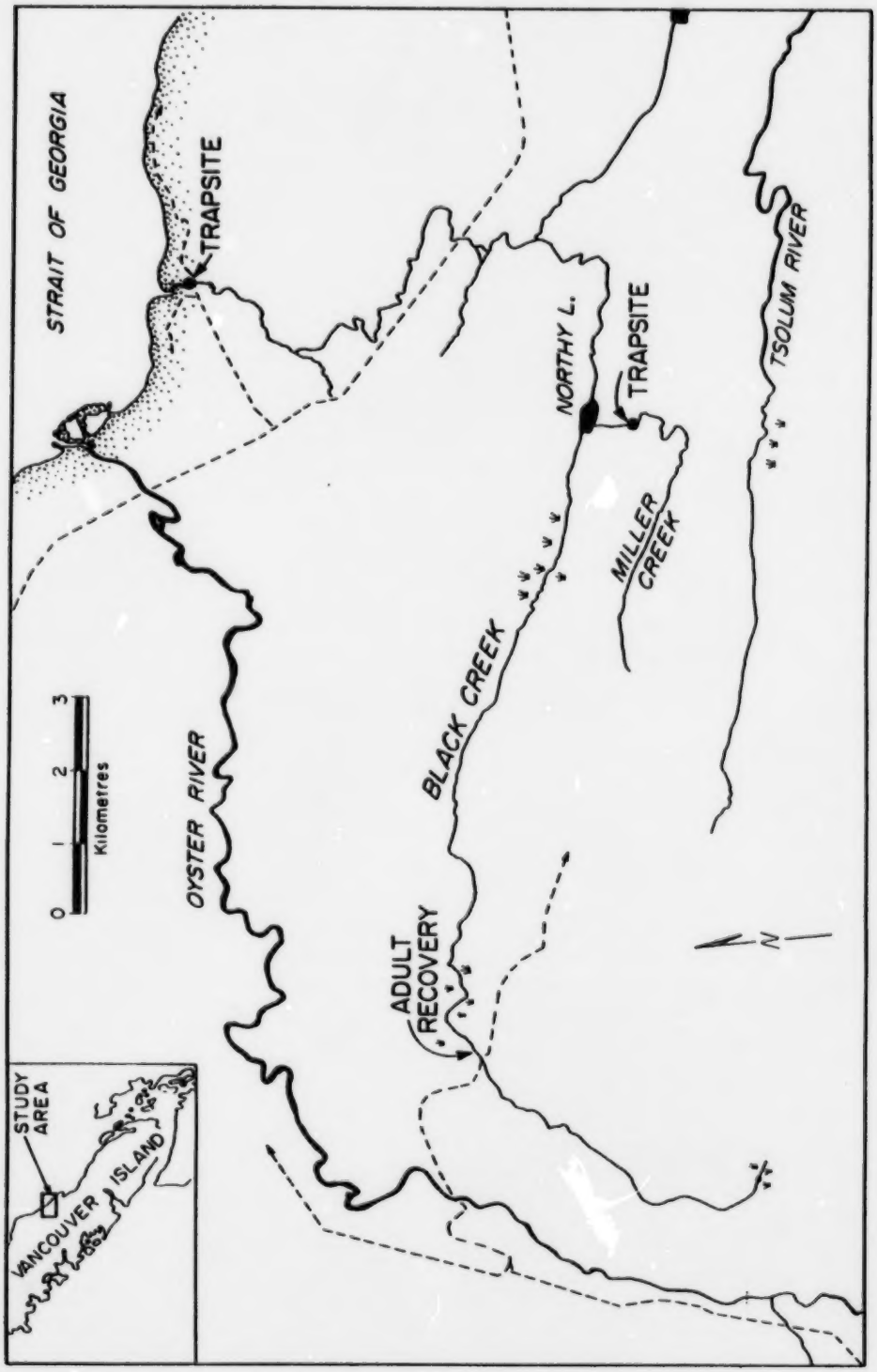


Fig. 1. A map of the study area showing the locations of the traps on Black Creek and Miller Creek during 1978 and 1979. Inset shows the location of the study area on Vancouver Island.

The discharge in Black Creek can be as high as 21 m^3s^{-1} during heavy rainfall (Hamilton 1978) and yet there are periods during the summer when surface flow cannot be observed at the mouth of the creek. Swamps and small lakes apparently provide refugia for juvenile coho during low flows, hence smolt production has been sufficient to maintain an average adult escapement of 4900 coho from 1935 to 1976 (Hancock and Marshall 1985). Resident cutthroat trout (Salmo clarki) and some steelhead (S. gairdneri) are also present in the system.

The number of adult fish spawning in Black Creek is difficult to estimate visually because the swampy nature of the system results in dark, tea-coloured water. Accurate counts of spawned-out adults are particularly hard to obtain because spawning areas are scattered over many kilometers of inaccessible streambed interspersed with swamps created by beaver activity. To improve the accuracy of adult escapement estimates, a counting fence was constructed near the mouth of the creek in 1968 and the fence was rebuilt in 1972. Unfortunately, maintaining the fence proved to be labour intensive and no attempt was made to maintain it continuously throughout the spawning season until 1978.

METHODS

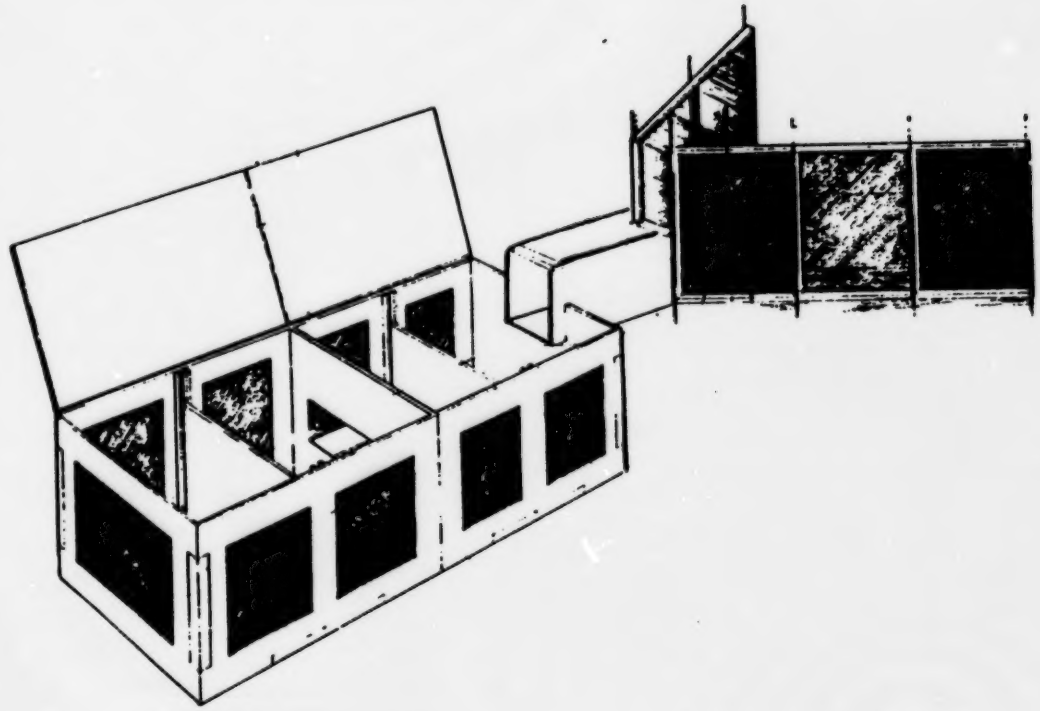
SMOLT TRAPPING

To estimate the numbers of downstream migrating coho salmon smolts in Black Creek, a temporary converging weir fence trap was installed in 1978 and again in 1979. This trap was 25 meters upstream of the concrete adult fence foundation, immediately upstream of the limit of tidal influence. To assess the contribution of swampy areas to the total smolt out-migration, a smaller smolt trap was installed in Miller Creek (Figure 1) in 1979. All fish caught leaving Miller Creek were counted and released immediately. No measurements were taken or marks applied to fish leaving Miller Creek.

Smolt fences were similar to those installed in the Cowichan River drainage (Argue et al. 1979). Two weirs, each 23 m long, converged at a double trap box in midstream, completely blocking the stream to fish movement. A 30 cm wire skirt on the bottom of the fence panels (Figure 2) was added to reduce the possibility of fish escaping under the fence wings.

Water levels at the Black Creek trap were controlled using stoplogs slid into I-beams that were part of the adult fence. The water levels were controlled so that no adjustment to trough levels was necessary when flows fluctuated.

The traps were normally checked each morning and several times during the day. Six holding boxes were used at Black Creek to hold coho smolts until sufficient numbers were available to tag and to retain fish after tagging. To prevent predation by otters and mink, the trap entrance was closed between 2200 h and 0500 h from May 6 to June 2, 1978, and occasionally



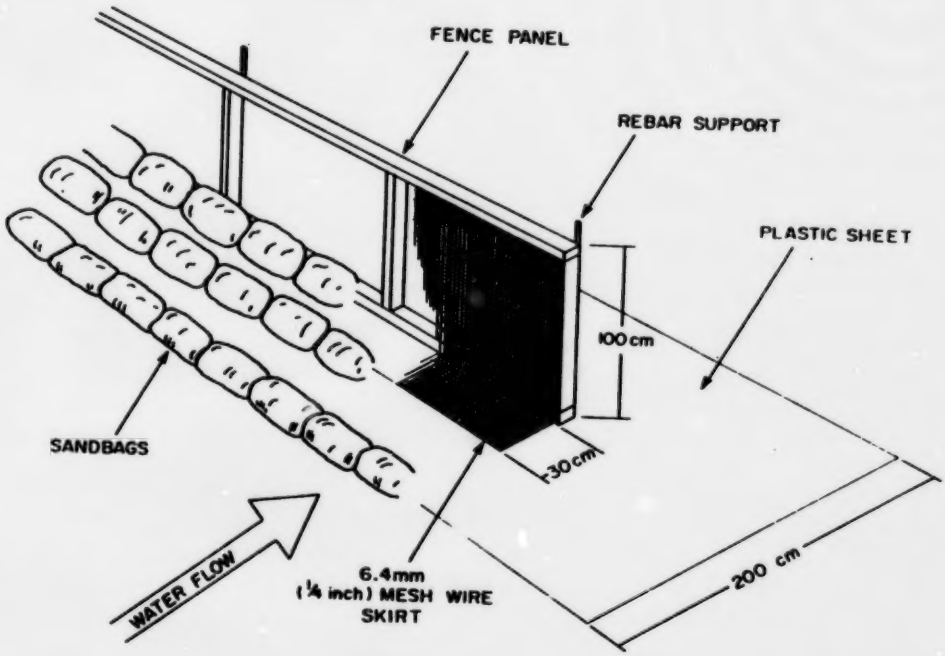
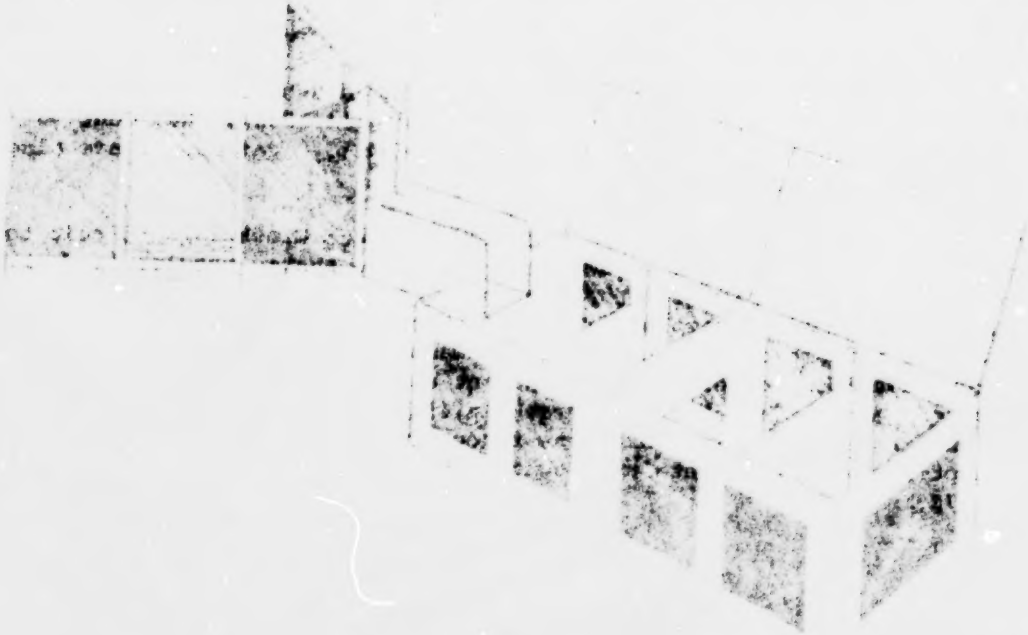


Fig. 2. The standard fence and trap arrangement (from Armstrong and Argue 1977) and modifications to the fence panels used at Black Creek during 1978 and 1979.



in 1979. Water temperatures and levels were recorded daily, usually first thing in the morning.

Trap Efficiency

To assess the ability of the fence to divert smolts into the trap, groups of tagged, double-clipped (adipose and one lobe of the caudal fin) coho smolts were released 100 m upstream of the trap during both years. Smolts subsequently captured at the trap were examined for fin clips.

SMOLT TAGGING

The marking and tagging procedure and equipment were identical to that described by Armstrong and Argue (1977). The fish caught in the trap were anaesthetized with Tricaine Methanesulfonate (MS222) prior to fin clipping and tagging. The adipose fin was removed using optical surgical scissors. After tagging, fish were held for a short time until they recovered. They were then allowed to escape from open holding boxes into a natural pool just downstream of the trap. Two tag codes were used each year, one on fish migrating before the peak in smolt timing and one after the peak. Tag depth was checked within each tagging period by dissecting several average size smolts. Checks for immediate tag loss were frequently made by removing fish randomly during the tagging process and holding them for 24 hours and then passing them through the quality control device again.

Biological Sampling of Smolts

Groups of up to 100 coho from each holding box (usually one day's catch) were sampled by removing fish randomly after tagging. Each fish was anaesthetized and then nose-fork lengths were measured to the nearest 0.1 cm and wet weights were taken to the nearest 0.1 g. At least five scales were taken from the preferred area from both sides of the fish. A total of 1170 scale samples were taken in 1979 and 800 samples were taken in 1980. Scale samples were interpreted by personnel at the Department of Fisheries and Oceans scale lab in Vancouver.

ADULT ENUMERATION

The adult fish counting fence was sloped downstream at an angle of approximately 30 degrees and included nine moveable panels that slid into I beams imbedded in a concrete foundation. The fence panels could be slid up and down and removed for cleaning and storage. Concrete bulkheads on both banks were connected with a walkway approximately 1.5 m above the streambed. With all of the panels in place and with appropriate flow levels, the fence was a complete barrier to fish movement. The spacing between the bars on the panels was small enough (2.5 cm) to force coho jacks and cutthroat trout as

well as adult coho to enter the trap box. The trap box confined fish after they had moved upstream through a cone that tapered to a 10 cm wide opening. The trap box was large enough that we could stand inside to dipnet the fish out after identifying them and checking them for marks. Slight modifications and improvements to the trap box were made each year.

The adult fish counting fence was installed in the fall as soon as possible following the first small increase in discharge. Before then adult coho would often hold in a pool downstream of the counting fence. When the water level was low, there was insufficient flow to attract fish into the trap. To avoid holding up the run during low flows, the fence panels were removed and the fish were counted as they swam over a white board placed on the bottom of the stream.

During moderate water levels, the fence panels were cleaned one at a time by lifting the panels and removing the leaves and debris. On rising water levels the debris load increased, and this meant extra cleaning was necessary. Since many fish entered Black Creek on the rising portion of the first high water period of each fall, every effort was made to keep the fence closed to fish movement during this time so that the fish could be counted through the trap. The panels were only cleaned when necessary and they were cleaned one at a time. During high flows, it was sometimes necessary to remove three panels at a time for cleaning, and occasionally the panels had to be left open. Some fish may have moved upstream uncounted during the cleaning process.

When the fence panels were removed to allow fish passage, fish could be counted but it was sometimes difficult to identify them and check them for marks. These fish were recorded as "not checked". It is possible that a few of the "not checked" coho jacks may have been cutthroat trout. Also, at night when conditions did not permit fish to be handled, many were released as "not checked".

To minimize holding time, three crew members were on standby 24 hours a day in each of the three years. The trap was checked first thing in the morning and also during the day if fish were migrating. The trap box was locked whenever crew members were not in attendance to prevent vandalism.

The fish fence was installed and operated during the following periods: 11 Sept. to 30 Nov. 1978; 8 Sept. to 26 Nov. 1979; 9 Sept to 28 Nov. 1980. In 1978 it was never necessary to remove the fence panels completely. In 1979, fence panels were removed from 1800 h Oct. 25 to 0900 h Oct 27, and from 1500 h Oct 27 until 0900 h Oct 28. In 1980, fence panels were removed during 6-8 Nov., 21-22 Nov. and on 27 Nov. Normally, fish caught in the trap were identified to species and checked for fin clips. Jack coho were checked for missing adipose fins and released if no fin was missing. Jacks with missing adipose fins were killed and kept for tag recovery. The heads from jack coho with missing adipose fins were kept frozen and when the field study was completed the heads were delivered to the Georgia-Johnstone Strait Headwater Tag Head Recovery lab in Vancouver where the tags were removed and tag codes determined.

Adult coho were checked for missing fins, their sex was recorded and the fish were released. With one exception (10 fish used as brood stock),

live adults were never taken for tag recovery. To reduce the stress on the fish, handling was kept to a minimum and no measurements were taken at the fence. In 1980, post-orbital hypural lengths were measured from twenty-seven adults recovered from the spawning grounds.

TAG RETURNS

The only unspawned adults killed were the 10 fish taken for brood stock and only one of these fish was marked. In 1979, spawning ground recovery efforts were done after the main spawning period. No live fish were seen and only parts of carcasses were recovered, so no samples were obtained. In 1980, only a small number of marked spawned-out fish were recovered from the spawning grounds. These are the only adults available to estimate the numbers of each tag code that returned to the stream. A total of seventeen spawned out adults thought to have missing adipose fins were measured for length and their heads were kept for tag recovery during the 1980 escapement.

The numbers of tagged fish captured in the commercial and sport fisheries were obtained through the Mark Recovery Program. In this program, commercial fishery tag recoveries were obtained by sampling a portion of each days catch at canneries and defining the catch:sample ratio from reported landings and numbers sampled. The target sample to catch rate was 20%. The tag recoveries are grouped into fishery-time segments where appropriate catch-timing data exists. Sport recoveries were obtained from voluntary returns of marked heads to a network of 150 head recovery depots. The expansion factor for sport recoveries is assumed to be 4.0 for sport returns. The Mark Recovery Program has been described by Argue (1976) and Bailey et al.(1983). The catch regions used in this report and the results of the Canadian Mark Recovery Program are given in Simpson et al. (1981a and 1981b). Recoveries in United States waters were conducted by a similar program in Washington, Oregon and Alaska (Anonymous 1984; O'Connor 1982).

RESULTS AND DISCUSSION

SMOLT ENUMERATION

Trap Catch

Trapping conditions were ideal in 1978 and 1979 with stable stream flows gradually decreasing from April to June. Flows were never high enough to allow fish to bypass the fence although flows occasionally did decrease so that fish could not enter the trap. A total of 46,405 coho smolts were caught between April 27th and June 8th 1978, and a total of 46,566 coho smolts were caught between April 18th and June 17th, 1979 (Appendix 1 and 2, Figure 3).

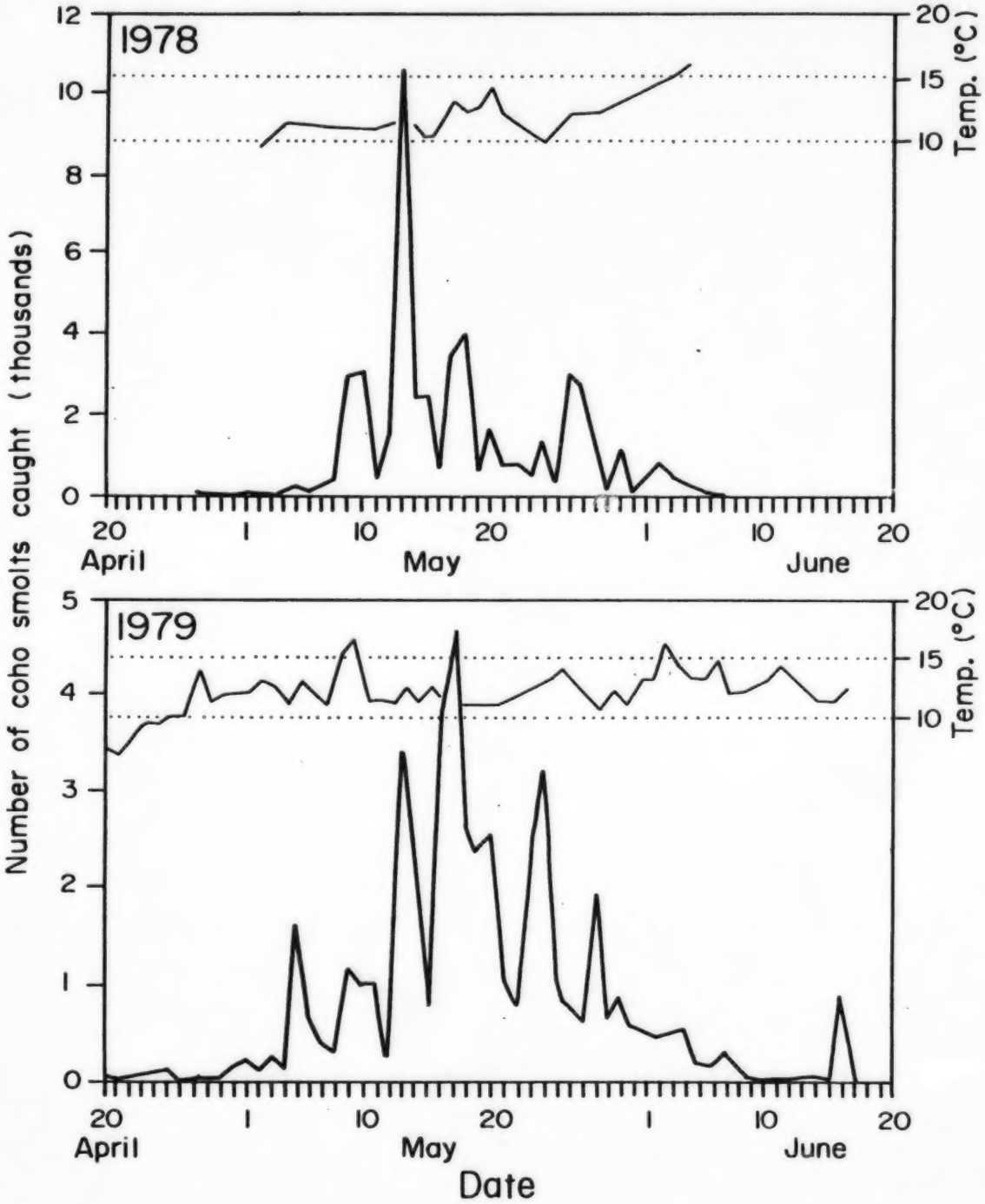


Fig. 3. Daily coho smolt catch and temperature readings taken at Black Creek during 1978 and 1979.

The peak migration occurred between May 12th and May 19th in 1978 and between May 14th and May 20th in 1979. No definite diel pattern of smolt movement was observed. In 1979, 3503 coho smolts were caught leaving Miller Creek between April 21st and June 1st, 7.6% of the total catch at the mouth of Black Creek. These fish were generally smaller than the smolts caught in Black Creek.

Sculpins (Cottus spp), cutthroat trout, steelhead smolts and threespine stickleback (Gasterosteus aculeatus) were caught sporadically with no peak periods of movement occurring (Table 1).

Table 1. Total number of fish caught moving downstream at Black Creek during the spring of 1978 and 1979.

	1978	1979
Coho smolts	46,405	46,566
Coho fry	8	224
Steelhead smolts	162	35
Steelhead adults	0	10
Cutthroat trout	91	167
Sculpins	274	319
Sticklebacks	20	77
Lamprey	4	18

Trap Efficiency

Trap efficiency was estimated in May 1978 when 396 adipose and bottom caudal clipped fish were released after the peak migration. A total of 342 of the 396 were recovered (86%), mostly shortly after their release. As marked fish were still being recovered when the trap was removed three weeks after the upstream release, this percentage is probably an underestimate. An earlier trap efficiency test in 1978, and one in 1979 conducted near the final trap removal, were not considered valid and results are not given. The estimated coho smolt production was 5% greater than the numbers of smolts counted to account for smolts leaving the stream before the trap was installed and after it was removed.

SMOLT TAGGING

In 1978, coded-wire tag loss checks were conducted on seven groups of fish (1,212 fish total) yielding and average tag loss of 1.6% (Appendix 3). An estimated 14,965 coho smolts were released with code 02-20-39, and 14,941 coho smolts were released with tag code 02-16-53. An estimated 464 coho smolts were released without tags but were marked by the removal of their adipose fin. An additional 16,035 coho smolts were released without being marked or tagged. The total number of coho smolts counted through the fence

was 46,405 and the total smolt production was estimated at 48,725.

In 1979, tag loss checks were conducted on thirteen groups of fish (4184 total) yielding an average tag loss of 1.8% (Appendix 3). An estimated 21,408 coho were released with code 02-20-59 and an estimated 17,968 fish were released with code 02-20-61. An estimated 637 fish were released without coded wire tags but were marked by removal of their adipose fin. An additional 6553 smolts were released without being marked or tagged. The total number of coho smolts counted through the fence was 46,566 and the total smolt production was estimated as 48,894.

Immediate tagging mortality was less than 1% in both 1978 (63/3,433) and 1979 (38/40,051). Six coho smolts were observed with naturally missing adipose fins in 1978 (0.02%, 6/30,433) and eleven in 1979 (0.03 %, 11/40,316).

Age Size and Weight of Coho Smolts

The majority of the 1978 coho smolts were age 1+ (96.6%, 720/745) and could not be distinguished on the basis of their size from the remainder which were age 2+ (Appendices 4 and 5, Figures 4 and 5). The mean length of migrating 1+ smolts was 115 mm and 2+ smolts was 123 mm. In 1979, the majority of the coho smolts were again age 1+ (98.4%, 731/799). The mean length of 1+ smolts was 110 mm and 2+ smolts was 142 mm.

The largest and heaviest smolts migrated downstream first (Figures 6 and 7). In 1978 the smolts chosen for tagging using the first tag code were significantly larger and heavier than the post peak smolts. In 1979 the same trend occurred but the sizes of the two groups were not significantly different.

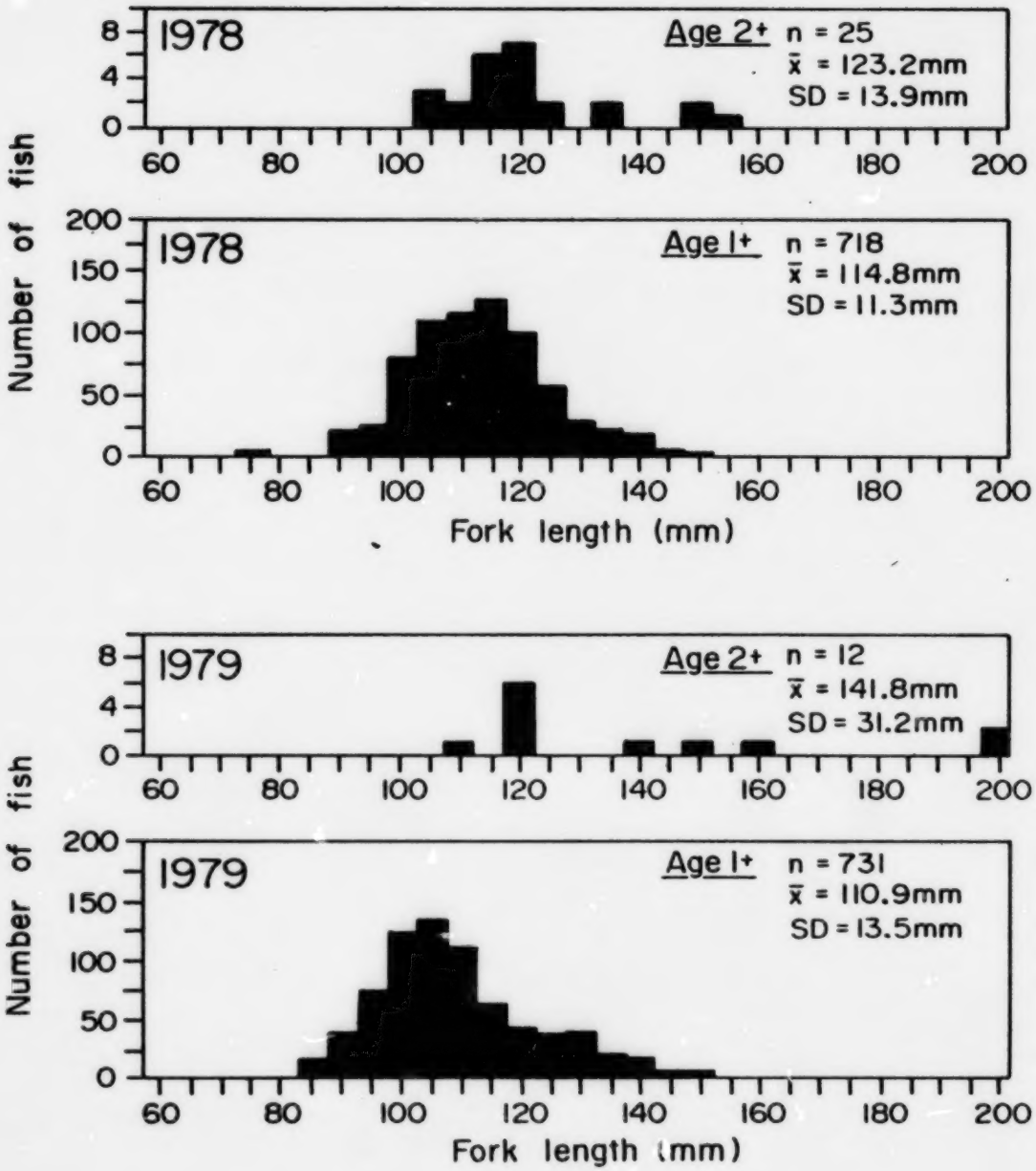


Fig. 4. Length frequency distribution of coho smolts tagged at Black Creek during 1978 and 1979.

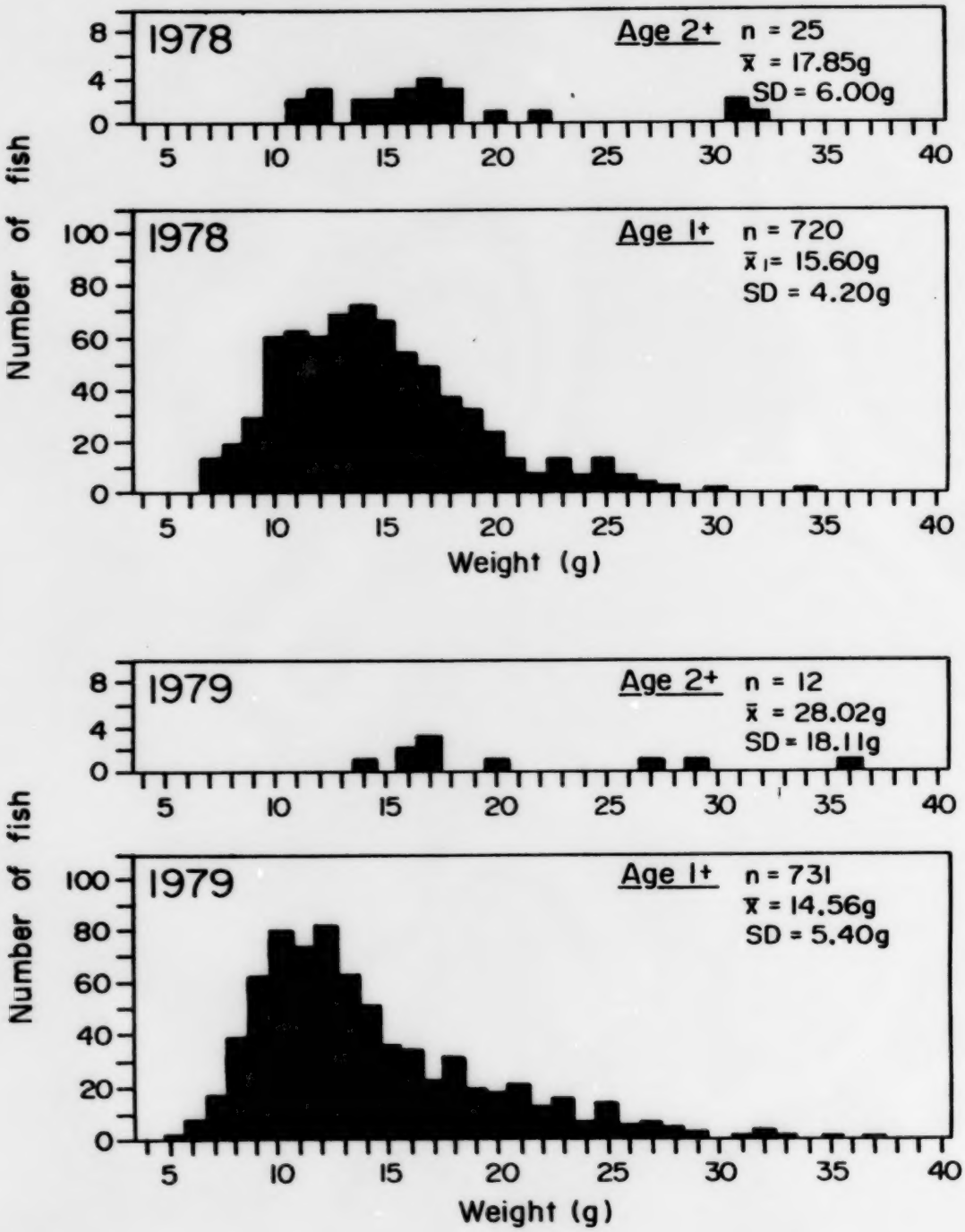


Fig. 5. Weight frequency distribution of coho smolts tagged at Black Creek during 1978 and 1979.

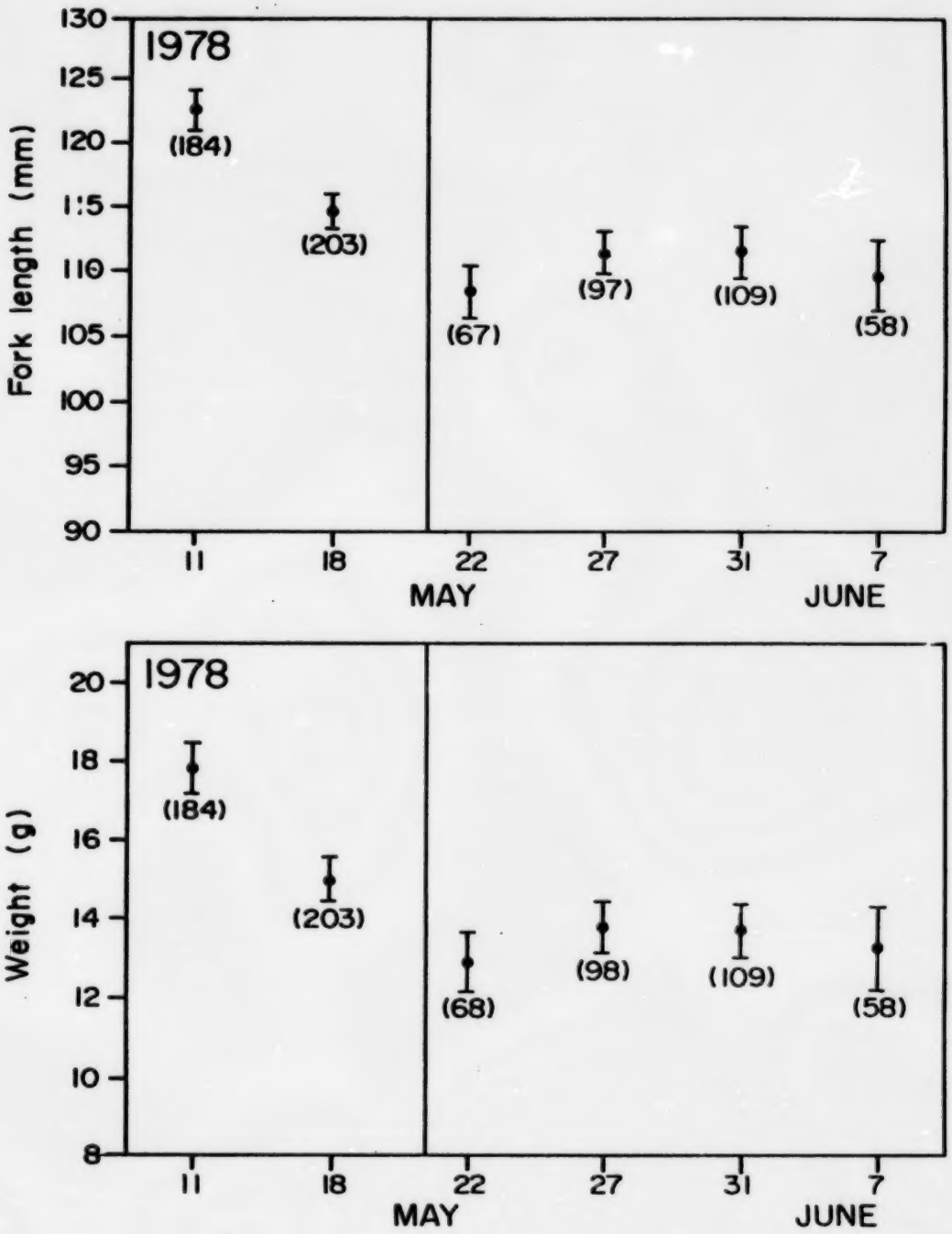


Fig. 6. Mean lengths and weights, 95% confidence intervals and sample sizes (in brackets) of age 1+ coho smolts tagged at Black Creek during 1978. Vertical line shows the separation in time of the two tag codes used.

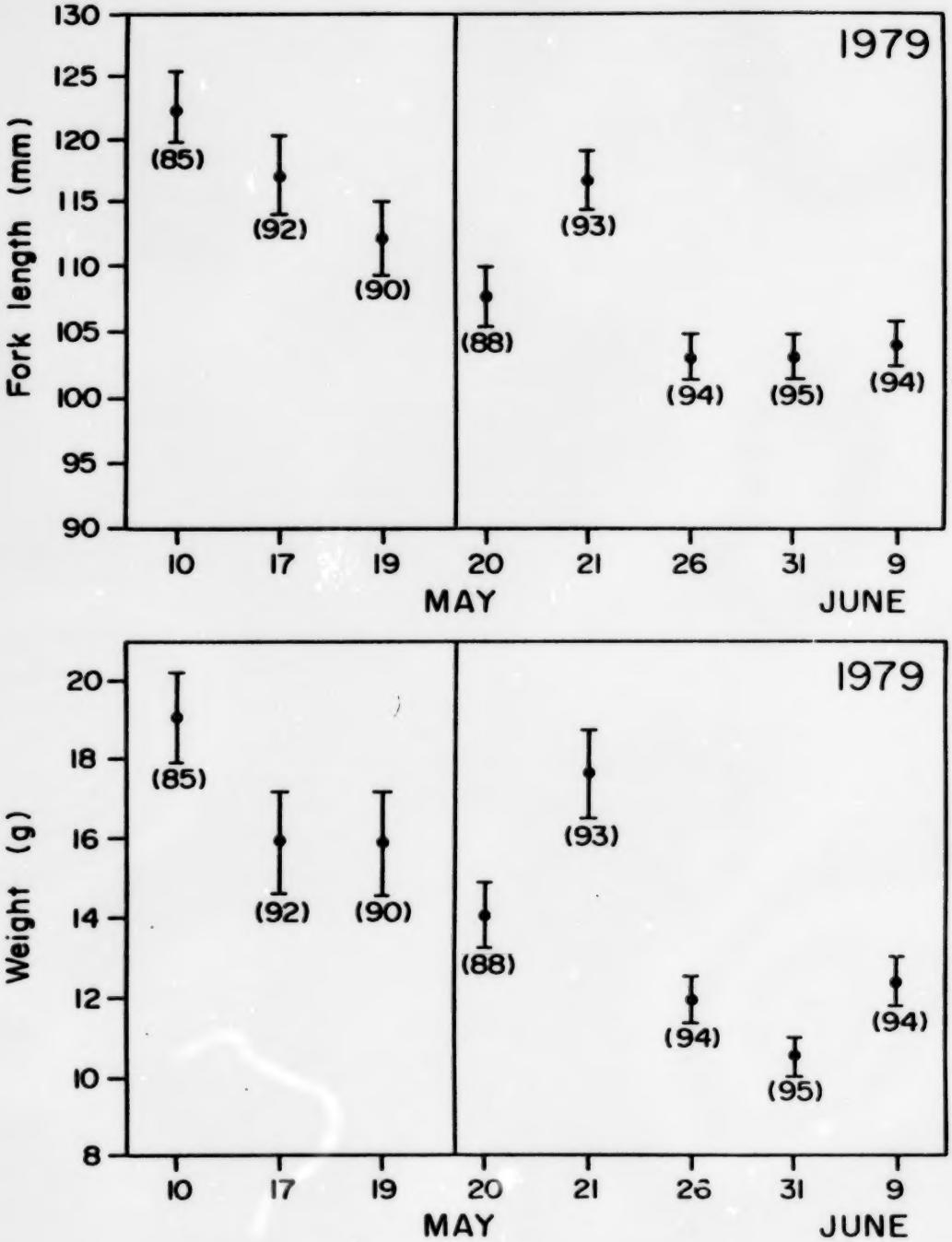


Fig. 7. Mean lengths and weights, 95% confidence intervals and sample sizes (in brackets) of age 1+ coho smolts tagged at Black Creek during 1979. Vertical line shows the separation in time of the two tag codes used.

ADULT ENUMERATION

Escapement Counts

The number of coho enumerated ranged between 1190 and 8391 (Table 2). The timing of fish entering Black Creek appeared to depend on stream flow conditions. Although adult coho were seen in the ocean near the mouth of the creek in late summer, they waited until stream flows increased enough to allow them to enter the creek. The earliest fish were caught at the trap was September 8 (1979); the latest was November 27 (1980). The major portion of the migration occurred with the first high water period (Figure 8).

Not all adult coho returning to Black Creek were counted at the fence. In 1979 and 1980, some fish undoubtedly passed upstream uncounted when fence panels were open either for cleaning or during high water. We believe that escapements in 1979 were 15% greater than trap counts and in 1980, approximately 10% greater than the number of fish counted at the trap. These expansion factors were determined by estimating the number of fish migrating past the fence uncounted when the fence was not fully operational (Appendices 6, 7, and 8).

Table 2. Total trap counts and estimated total coho escapements to Black Creek in 1978, 1979, and 1980.

	1978	1979	1980
ADULT COHO			
Marked		94	266
Not marked	7587	66	128
Not checked		555	1358
Total counted	7587	715	1752
Total estimated	7587	822	1927
COHO JACKS			
Marked	238	363	
Not marked	321	110	1097
Not checked	245	2	
Total counted	804	475	1097
Total estimated	804	546	1207
Total counted	8391	1190	2849
Escapement estimate	8391	1368	3134

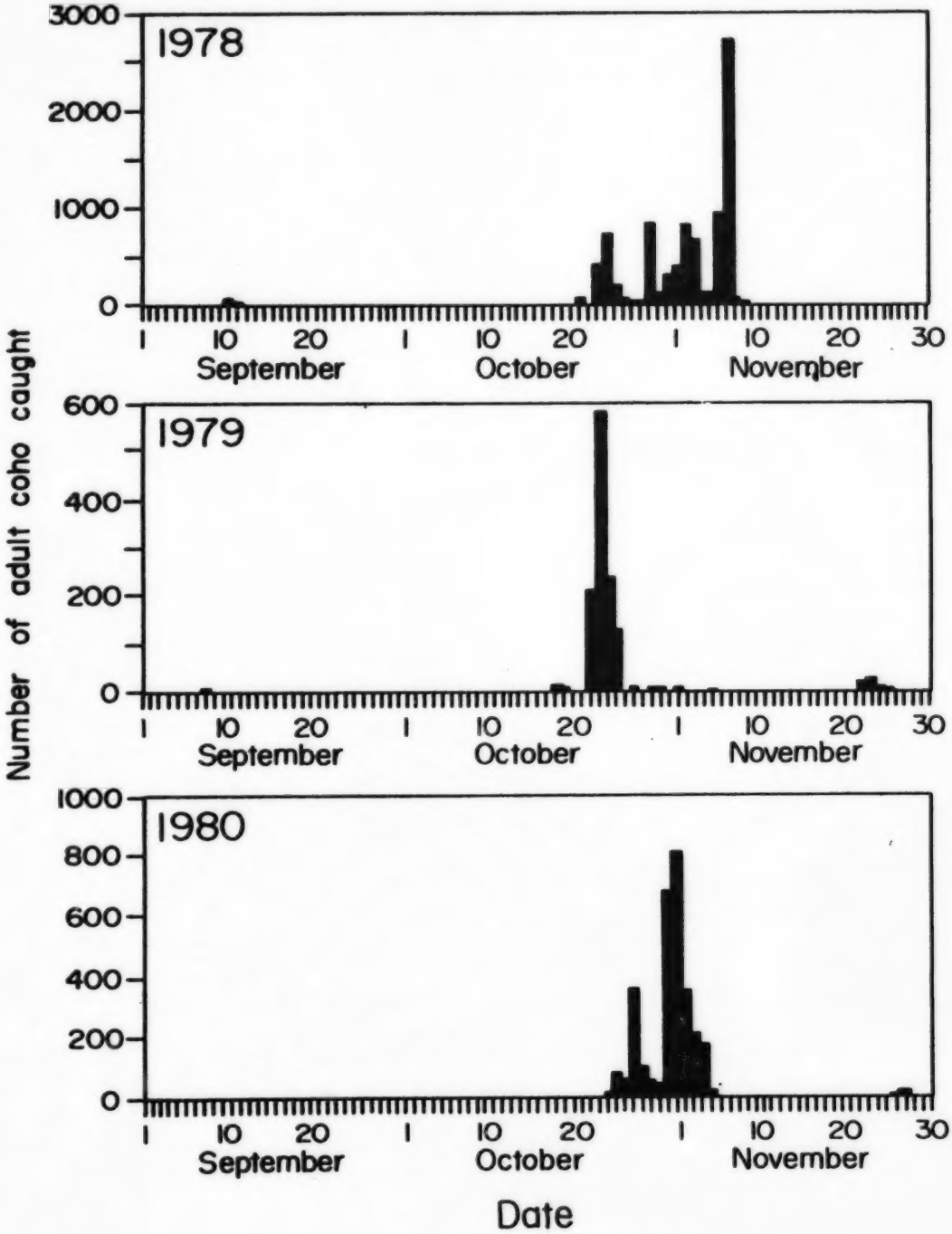


Fig. 8. Daily catch of adult coho migrating upstream at Black Creek in 1978, 1979, and 1980.

Jack Size and Age

Coho identified as jacks returning to Black Creek in 1979 were predominantly age 2 (122/127). Five were age 3, four of which were tagged after the peak of downstream migration. The mean size was 28.2 cm (n=238).

In 1979, only a portion of the marked jacks returning were sampled so sample size is smaller. These fish were predominantly age 2 (34/35) with only one age 3. The mean size in 1979 was 25.9 cm (n=61).

TAG RETURNS IN THE ESCAPEMENT

1976 Brood

The coho resulting from spawning that occurred in 1976 were tagged in the spring of 1978 and the jacks were recovered in the fall of 1978. In 1978, every marked jack identified in the trap was killed and the tag was recovered. Additional marked jacks escaped upstream when fish were not checked for marks. A estimated 342 marked jacks returned in 1978 (marked to unmarked in those checked 238:321; total counted = 804; 804 x 238/559 = total marked jacks). This represents a total of 310 jacks tagged with code 02-20-39 and 32 with code 02-16-53 (observed 195 and 20 respectively (Table 3)). The majority of the jacks were from smolts tagged prior to the peak of migration, when the largest smolts were leaving the stream. One fish tagged at Lummi near Seattle, Washington returned with the Black Creek coho.

Table 3. Tags recovered from marked coho jacks sampled at Black Creek in the fall of 1978, and 1979.

1978 Recoveries		1979 Recoveries	
Tag Code	Number Recovered	Tag Code	Number Recovered
02-20-39	195	02-20-59	58
02-16-53	20	02-20-61	2
No pin	12	No pin	0
Pin lost	10	Pin lost	1
01-18-05 (Lummi)	1		
Total	238	Total	61

It was possible to check only 20% of the total adult escapement for missing adipose fins. The number of marked fish returning was estimated from the sample that was checked. We estimated that 483, of the 1976 brood coho returned as marked adults (822 x 94/160). Only one marked adult was recovered so the marks could not be divided into returns of each tag code, based on the escapement.

1977 Brood

The coho resulting from spawning that occurred in 1977 were tagged in the spring of 1979 and the jacks were recovered in the fall of 1979. A total of 419 marked jacks returned in 1979, the majority of which were tagged before the peak of downstream migration (546 x 363/473) (Table 3). An estimated 1301 marked adults returned in 1980 (1927 x 266/394). Only 17 marked heads were recovered for tag recovery. Of these marked adults, 12 were tagged with code 02-20-59 and 1 with code 02-20-61. Four of the heads did not contain a tag.

TAG RETURNS IN THE FISHERY

Tag recoveries were reported from Alaska to Oregon, with the majority being recovered in the Georgia Strait sport fishery (Table 4). Recoveries were similar for each brood year, with the early tag code being recovered more than the late code in the West Coast Vancouver Island Troll fishery. The reverse occurred in the Georgia Strait Troll fishery where the late tag code was recovered more than the early code.

Table 4. Distribution of the estimated catch from 1978 to 1981 (numbers and percentages) of coho salmon coded-wire tagged at Black Creek during 1978 and 1979.

AREA	TAG CODES 1978			TAG CODES 1979			TOTAL ALL CODES	
	EST. CATCH 02-20-39	EST. CATCH 02-16-53	BOTH CODES PERCENT	EST. CATCH 02-20-59	EST. CATCH 02-20-61	BOTH CODES PERCENT	EST. CATCH	PERCENT
ALASKA	0	0	0	3	0	0.05	3	0.03
NC TROLL	221	289	9.87	579	242	13.36	1331	11.77
NC NET	9	18	0.52	22	28	0.81	77	0.68
NC SPORT	0	0	0	12	5	0.28	17	0.15
WCVI TROLL	414	266	13.16	644	350	16.18	1674	14.8
WCVI NET	3	0	0.06	13	3	0.26	19	0.17
WCVI SPORT	4	0	0.08	0	0	0	4	0.04
GS TROLL	176	287	8.96	335	266	9.78	1064	9.41
GS NET	526	383	17.6	656	503	18.87	2068	18.29
GS SPORT	1000	1483	48.06	1106	1064	35.32	4653	41.15
WA ORG	53	34	1.68	160	151	5.06	398	3.52
TOTAL	2406	2760		3533	2610		11308	100
TOTAL BROOD YEAR		5166	100		6143	100		

Catch Regions are defined in Simpson et al., 1981a. NC-North and Central Coast; WCVI-West Coast Vancouver Island; GS-Juan de Fuca Strait, Johnstone Strait, and Strait of Georgia; WA-Washington and Puget Sound; ORG-Oregon.

The Georgia Strait sport fisheries harvested an estimated 41% of the catch of coho tagged in Black Creek in 1978 and 1979. The inside net fisheries in Juan de Fuca and Puget Sound captured a significant share (18%), and the West Coast Vancouver Island Troll fishery made up 15% of the catch (Figure 9).

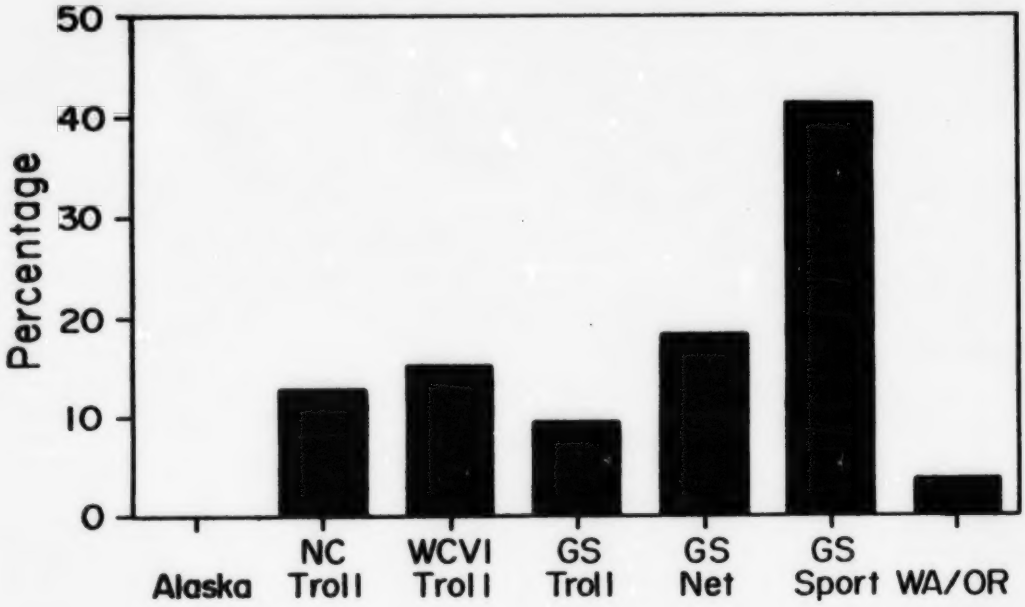


Fig. 9. Distribution (percentage) of the estimated catch of coho salmon tagged at Black Creek during 1978 and 1979.

Total Catch

The catch of tagged 1976 brood coho was estimated to be 5,166; the catch of 1977 brood coho was estimated to be 6,143 (Table 4). Based on the marked to unmarked ratio in the escapement, the number of tagged fish caught was expanded to include unmarked fish. The total number of fish caught in sport and commercial fisheries of the 1976 brood was estimated to be 8,793, and of the 1977 brood, 9,099.

CATCH AND ESCAPEMENT

The number of tags recovered in the sport and commercial fisheries was compared to the number of marked fish in the escapement to derive catch to escapement ratios (C:E). The number of tags in the escapement was estimated from the number of marked adults in the escapement, reduced by the tag loss at smolt tagging and after 24 hours of holding at the creek. Tag codes were

lumped for each brood year. The tag codes were not separated in the adult escapement because not enough marked fish were sampled to determine the tag code distribution in the escapement. The catch:escapement ratio for the 1977 brood year was 6.4:1, and for the 1977 brood year, 3.6:1 (Table 5).

Table 5. Catch to escapement estimates for the 1976 and 1977 broods of Black Creek coho.

Brood Year	Estimated Tags Caught	Estimated Tags in Escapement		Catch:Escapement Ratio
1976	5166	marked jacks	342	
		marked adults	483	
		less 1.6% tag loss	-13	
			812	6.4:1
1977	6143	marked jacks	419	
		marked adults	1301	
		less 1.8% tag loss	-31	
			1689	3.6:1

Survival Rate by Brood Year

The total catch plus escapement was used to provide an estimate of the survival rate from smolts to adults. The survival rate for the 1976 brood Black Creek coho was 21.4% and for 1977 brood 23.9% (Table 6).

Table 6. Survival rates for the 1976 and 1977 broods of Black Creek coho.

Brood Year	Estimated Smolt Production	Catch	Estimated Escapement	
1976	48,725	8793	jacks	804
			adults	822
				1626
	Smolt to adult survival = 21.4%			
	Marine survival smolt to escapement = 3.3%			
1977	48,894	9099	jacks	546
			adults	1927
				2577
	Smolt to adult survival = 23.9%			
	Marine survival smolt to escapement = 5.3%			

CONCLUDING COMMENTS

Black Creek is one of the few remaining wild streams on the east coast of Vancouver Island producing significant numbers of coho salmon and therefore statistics documenting the life history of Black Creek fish are important. Numbers of coho smolts, their age and size distributions, and timing of migration were consistent for the two years the smolt enumeration fence was operated. Coded-wire tag results from these two years yielded similar results. Approximately 24% of the smolts survived to the fishery. The Georgia Strait sport fishery caught the largest proportion of the catch (41%), followed by the Georgia Strait and Juan de Fuca Strait net fishery and the troll fishery off the west coast of Vancouver Island. The total exploitation rate estimated for this stock was similar each year, averaging 83% (Figure 10). The number of coho returning to Black Creek however, was highly variable, suggesting that either significantly different proportions of the run were able to escape the fishery in different years, or that in years of low escapement, there may have been high mortality while the fish were waiting for flows adequate to allow them to enter Black Creek.

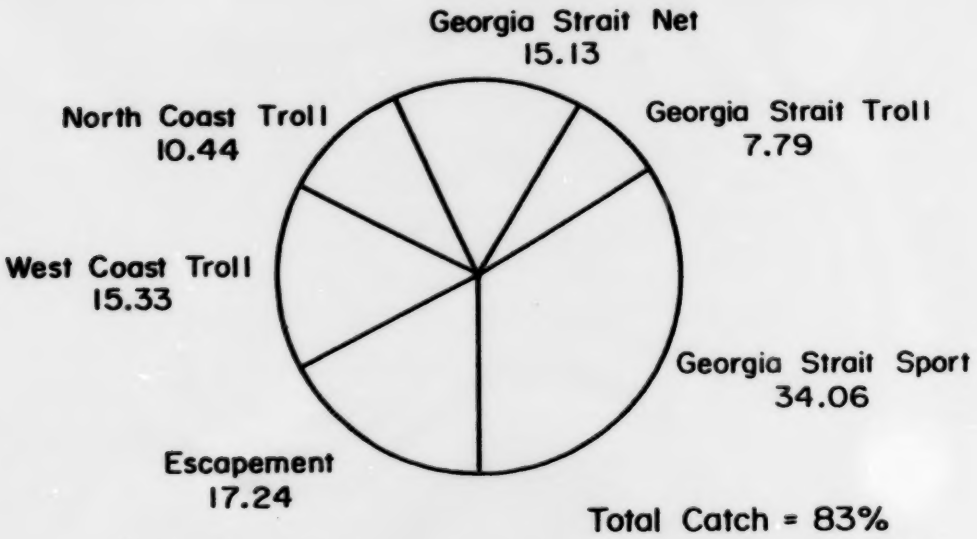


Fig. 10. Distribution (percentage) of the estimated catch and escapement for Black Creek coho tagged in 1978 and 1979.

This information indicates that natural streams can maintain populations of unenhanced coho salmon in spite of moderately heavy exploitation pressures, provided that the stream habitat is adequate to permit high production and survival of smolts. To protect important stocks like those of Black Creek, factors contributing to freshwater production should be identified so that quality coho habitat can be protected.

ACKNOWLEDGMENTS

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We would like to acknowledge the late Bill LeChasseur for his interest and dedication to preserving the Black Creek coho which resulted in these projects being pursued.

LITERATURE CITED

Anonomous. 1984. 1979 Pacific Salmonid coded-wire tag recoveries. Regional Mark Processing Centre Pacific Marine Fisheries Service. January 1984.

Argue, A. W. 1976. Preliminary information from the 1973 and 1974 Canadian chinook and coho catch sampling and mark recovery programs. Canada Dept. of Fisheries and Environment, Fish. Serv. Pacific Region Tech. Rep. PAC/T-76-9. 32p.

Argue, A. W., and R. W. Armstrong. 1977. Coho smolt coded-wire tagging and enumeration (1971 to 1973 broods) on three small tributaries in the Squamish River system. Canada Dept. of Fisheries and Environment, Fish. Serv. Pacific Region Data Report Series PAC/D-77-77. 77p.

Argue, A. W., L. M. Paterson, and R.W. Armstrong. 1979. Trapping and coded-wire tagging of wild coho, chinook and steelhead juveniles from the Cowichan-Koksilah River system, 1976. Fish. Mar. Ser. Tech. Rep. 850: vi+117p.

Armstrong, R. W., and A. W. Argue. 1977. Trapping and coded-wire tagging of wild coho and chinook juveniles from the Cowichan River system, 1975. Canada Dept. of Fisheries and Environment, Fish. Serv. Pacific Region Tech. Rep. PAC/T-77-14. 58p.

Bailey, D., V. Palermo, T. Mosley, and J. Kokubo. 1983. Basic data for the 1980 Canadian salmonid catch sampling and mark recovery program. Can. Data Rep. Fish. Aquat. Sci. 368: 428p.

Conlin, K., and B. D. Tutty. 1979. Juvenile salmonid field trapping manual. Fish. Mar. Serv. MS Rep. 1530: 136p.

Hamilton, R. E. 1978. Black Creek, Vancouver Island B.C., hydrology, fisheries resource, and watershed development. Fish. Mar. Serv. MS Rep. 1484: 42p.

Hancock, M. J., and D. E. Marshall. 1985. Catalogue of salmon streams and spawning escapements of statistical area 14 Comox-Parksville. Can. Data Rep. Fish. Aquat. Sci. 504: 134p.

Simpson, K., J. A. Kokubo, and T. A. Mosley. 1981a. Basic data for the 1978 Canadian salmonid catch sampling and mark recovery program. Can. Data Rep. Fish. Aquat. Sci. 196: 3115p.

Simpson, K., T. A. Mosley, and J. A. Kokubo. 1981b. Basic data for the 1979 Canadian salmonid catch sampling and mark recovery program. Can. Data Rep. Fish. Aquat. Sci. 197: 3133p.

Waldichuk, M. 1984. Chairman's summary. Can. Tech. Rep. Fish. Aquat. Sci. 1326: ix - xv.

Appendix 1. Daily water temperatures, levels and estimated numbers of fish caught at Black Creek during 1978.

DATE		WATER TEMP (°C)	WATER LEVEL (m)	COHO SMOLTS	COHO FRY
April	27		0.55	31	
	28		0.55	0	
	29		0.58	15	
	30		0.55	10	
May	1			52	
	2	9		31	
	3			15	
	4	11		0	
	5			202	
	6		0.4	112	
	7		0.38	0	
	8			400	
	9			2949	
	10			2984	
	11	10.5	0.35	336	
	12	11	0.35	1486	
	13	11	0.48	10500	
	14	11	0.51	2400	
	15	10	0.52	2450	
	16	11	0.47	600	
	17	13	0.47	3488	
	18	12	0.42	3977	
	19	12.5		633	
	20	14	0.37	1677	
	21	11.8		823	
	22	11	0.37	815	
	23			477	
	24	9.5		1372	
	25		0.37	296	
	26	12	0.36	3050	
	27		0.46	2708	
	28	12	0.42	821	
	29		0.42	182	
	20		0.38	1192	
	31		0.42	107	
June	1		0.34	0	
	2		0.34	873	
	3	15	0.32	462	
	4	16	0.32	287	
	5	14.5	0.32	220	2
	6		0.29	44	3
	7		0.29	68	3
	8	Trap removed		0	
			TOTAL	48145	8

Note: Trap catch estimates given here did not always equal counts during tagging.

Appendix 2. Daily water temperatures, levels and estimated numbers of fish caught at Black Creek, during 1979.

DATE		WATER TEMP (°C)	WATER LEVEL (ft)	COHO SMOLTS	COHO FRY
April	19	7	2.1	4	0
	20	7.5	2	46	0
	21	7	1.8	12	0
	22	8.5	1.6	24	0
	23	9.5	1.6	32	0
	24	9.5	1.6	61	2
	25	10	1.6	104	0
	26	10	1.55	9	0
	27	14	1.5	3	0
	28	11.5	1.5	7	0
	29	12	1.45	3	0
	30	12	1.45	130	0
May	1	12	1.42	183	0
	2	13	1.39	116	0
	3	12.5	1.4	270	0
	4	11	1.48	105	0
	5	13	1.6	1507	0
	6	12	1.65	649	0
	7	11	1.7	379	0
	8	15	1.7	273	0
	9	16.5	1.7	1166	0
	10	11.5	1.6	967	0
	11	11	1.55	1000	0
	12	11	1.55	260	0
	13	12.5	1.5	3429	0
	14	11.5	1.5	2520	0
	15	12.5	1.4	783	0
	16	11	1.4	3776	0
	17	11	1.35	4623	0
	18	11	1.3	2621	0
	19		1.3	2335	0
	20	11	1.32	2526	3
	21		1.3	1037	7
	22		1.3	774	1
	23		1.28	2479	0
	24	13	1.27	3191	10
	25	14	1.2	1010	0
	26			0	0
	27			639	6
	28	10.5	1.25	1917	9
	29	12	1.2	633	3
	30	11	1.2	842	7
	31	13	1.2	586	6
June	1	13	1.2	0	12
	2	16	1.2	475	22
	3	14	1.1	0	0
	4	13	1.1	545	21
	5	13	1.1	200	13
	6	14.5	1.1	174	7
	7	12	1	297	6
	8	12	1	0	0
	9	12.5	0.9	40	4
	10	13	0.9	0	0
	11	14	0.9	32	11
	12	No Flow		0	0
	13	No Flow		0	0
	14	11	1.07	40	26
	15	11	1	21	10
	16	12	1.1	870	37
	17	Trap removed			
			TOTAL	45813	223

Note: Trap catch estimates given here did not always equal counts during tagging.

Appendix 3. Black Creek coho smolt tag codes, holding time, number tagged, tag loss checks and total tagged released in 1978 and 1979.

TAGGING DATE	HOLDING TIME (days)	NUMBER TAGGED	TOTAL MORTS	NUMBER CHECKED	NUMBER WITHOUT TAGS	24 HOUR TAG LOSS	TOTAL TAGGED RELEASED	ADIPOSE ONLY
Early 1978 02-20-39						1.4%	14,965	205
May 10	1	3713	1	100	1			
May 11	2	3368	2	179	2			
May 16	3	3045	18					
May 17	3-5	4690	21	423	7			
May 18	0.5	396	0	0				
Late 1978 02-16-53						1.8%	14,941	259
May 22	2	3381	2	0				
May 26	1	5295	3	-				
May 27	0.5	729	0	96	3			
				100	5			
May 30	2	3966	9	124	0			
				190	1			
June 7	5	1850	7	0				
==========		========				==========	==========	==========
TOTAL 1978		30,370				1.6%	29,906	464
Early 1979 02-20-59						1.1%	21,408	217
May 9	1-6	3102	1	260	3			
May 10	1	2025	3	230	3			
May 11	1	1018	0					
May 15	2-4	3210	4	334	0			
May 16	1	4621	15	454	0			
May 17	1	3050	1	303	9			
May 18	0.5	4623	0	577	9			
Late 1979 02-20-61						2.6%	17,968	420
May 18	1	659	0	290	23			
May 19	1	2895	2	407	6			
May 20	1	3861	0	220	0			
May 24	1-4	4290	10	430	16			
May 25	1	2305	2	238	5			
May 30	1-5	2525	0	256	2			
Jun 30	2-7	1867	0	185	0			
==========		========				==========	==========	==========
TOTAL 1979		40,013				1.8%	39,376	637

Appendix 4. Black Creek coho smolt length frequency distribution by age and date of tagging, (a) 1978; b) 1979).

a) 1978

DATE TAGGED:	MAY 11		MAY 18		PREPEAK TOTAL		MAY 22		MAY 27		MAY 31		JUNE 7		POSTPEAK TOTAL		OVERALL RUN TOTAL		
AGE:	1+	2+	1+	2+	1+	2+	1+	2+	1+	2+	1+	2+	1+	2+	1+	2+	1+	2+	TOTAL
FORK LENGTH(cm)																			
7.0-7.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
7.5-7.9	-	-	1	-	1	-	-	-	-	-	-	-	-	-	-	-	1	-	1
8.0-8.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
8.5-8.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
9.0-9.4	-	-	5	-	-	-	4	-	5	-	3	-	4	-	16	-	21	-	28
9.5-9.9	1	-	6	-	5	-	5	-	3	-	5	-	6	-	19	-	26	-	46
10.0-10.4	2	-	20	-	7	-	15	-	12	-	23	-	10	-	60	-	82	-	119
10.5-10.9	14	-	28	1	22	-	18	-	17	-	26	1	8	1	69	2	111	3	175
11.0-11.4	26	-	38	-	42	1	10	1	21	-	11	-	11	1	53	2	117	2	197
11.5-11.9	31	3	43	1	64	-	9	-	21	-	14	2	11	-	55	2	129	6	214
12.0-12.4	41	2	32	4	74	4	3	1	12	-	13	-	2	-	30	1	103	7	183
12.5-12.9	28	-	11	1	73	6	2	-	5	1	8	-	3	-	18	1	57	2	89
13.0-13.4	13	-	12	-	39	1	-	-	1	-	1	-	1	-	3	-	28	-	38
13.5-13.9	12	1	4	-	25	-	-	-	-	1	3	-	1	-	4	1	29	2	31
14.0-14.4	12	-	3	-	16	1	1	-	-	-	-	-	1	-	2	-	17	-	21
14.5-14.9	2	-	-	-	15	-	-	-	-	-	2	-	-	-	2	-	4	-	7
15.0-15.4	2	-	-	2	2	-	-	-	-	-	-	-	-	-	-	-	2	2	6
15.5-15.9	-	1	-	-	2	2	-	-	-	-	-	-	-	-	-	-	-	1	1
16.0-16.4	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	1
SAMPLE SIZE:	184	7	203	9	387	16	67	2	97	2	109	3	58	2	331	9	718	25	1158
MEAN:	12.26	12.67	11.49	12.7	11.85	12.69	10.85	11.65	11.16	13.05	11.17	11.30	10.99	10.80	11.07	11.66	11.48	12.32	11.49
STANDARD DEV	1.06	1.44	1.05	1.58	1.12	1.47	0.90	0.92	0.88	0.64	1.12	0.53	1.06	0.42	1.01	0.98	1.13	1.39	1.13
STANDARD ERR	0.08	0.54	0.07	0.53	0.06	0.37	0.11	0.65	0.09	0.45	0.11	0.31	0.14	0.30	0.06	0.33	0.04	1.28	0.03

Note: OVERALL RUN TOTAL includes samples for which ages could not be determined.

Appendix 4 continued.

b) 1979

DATE TAGGED:	MAY 10		MAY 17		MAY 19		PREPEAK TOTAL		MAY 20		MAY 21	MAY 26	MAY 31	JUNE 6	POSTPEAK TOTAL		OVERALL RUN TOTAL		
AGE:	1+	2+	1+	2+	1+	2+	1+	2+	1+	2+	1+	1+	1+	1+	1+	2+	1+	2+	TOTAL
FORK LENGTH (cm)																			
8.0- 8.4	-	-	-	-	-	-	-	-	-	-	-	1	-	-	1	-	1	-	1
8.5- 8.9	-	-	1	-	1	-	2	-	3	-	-	4	6	2	15	-	17	-	17
9.0- 9.4	-	-	2	-	5	-	7	-	6	-	-	9	9	8	32	-	39	-	41
9.5- 9.9	2	-	9	-	5	-	16	-	7	-	5	13	17	16	58	-	74	-	78
10.0-10.4	5	-	8	-	16	-	29	-	19	-	10	30	17	19	95	-	124	-	128
10.5-10.9	7	-	8	-	14	-	29	-	17	-	12	20	29	28	106	-	135	-	149
11.0-11.4	9	-	20	-	19	-	48	-	17	1	17	9	9	12	64	1	112	1	123
11.5-11.9	15	-	7	-	6	-	28	-	3	-	20	2	5	5	35	-	63	-	68
12.0-12.4	7	1	10	3	7	1	24	5	4	1	7	4	2	2	19	1	43	6	54
12.5-12.9	12	-	5	-	5	-	22	-	6	-	7	1	1	1	16	-	38	-	40
13.0-13.4	11	-	10	-	5	-	26	-	6	-	7	-	-	1	14	-	40	-	43
13.5-13.9	8	-	4	-	2	-	14	-	-	-	3	1	-	-	4	-	18	-	19
14.0-14.4	7	-	5	-	2	-	14	-	-	1	3	-	-	-	3	1	17	1	20
14.5-14.9	1	-	2	-	-	-	3	-	-	-	1	-	-	-	1	-	4	-	5
15.0-15.4	1	1	-	-	2	-	3	1	-	-	1	-	-	-	1	-	4	1	5
15.5-15.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
16.0-16.4	-	-	1	1	-	-	1	1	-	-	-	-	-	-	-	-	1	1	2
16.5-16.9	-	-	-	-	1	-	1	-	-	-	-	-	-	-	-	-	1	-	1
17.0-17.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
17.5-17.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
18.0-18.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2
18.5-18.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
19.0-19.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
19.5-19.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
20.0-20.4	-	1	-	-	-	1	-	2	-	-	-	-	-	-	-	-	-	2	2
SAMPLE SIZE:	85	3	92	4	90	2	267	9	80	3	93	94	95	94	464	3	731	12	799
MEAN:	12.2	15.00	11.74	13.30	11.25	16.20	11.74	14.70	10.80	12.40	11.73	10.34	10.34	10.44	10.72	12.40	11.09	14.10	11.10
STD. DEV.:	1.27	4.03	1.49	2.07	1.43	5.37	1.46	3.36	1.14	1.44	1.20	0.89	0.85	0.84	1.12	1.44	1.35	3.12	1.50
STD. ERROR:	0.14	2.33	0.16	1.04	0.15	3.80	0.09	1.12	0.12	0.83	0.12	0.09	0.09	0.09	0.05	0.83	0.05	0.90	0.05

Note: OVERALL RUN TOTAL includes samples for which ages could not be determined.

Appendix 5. Black Creek coho smolt weight frequency distribution by age and date of tagging (a) 1978; b) 1979).

a) 1978

DATE TAGGED:	MAY 11		MAY 18		PREPEAK TOTAL		MAY 22		MAY 27		MAY 31		JUNE 7		POSTPEAK TOTAL		OVERALL RUN TOTAL		
AGE:	1+	2+	1+	2+	1+	2+	1+	2+	1+	2+	1+	2+	1+	2+	1+	2+	1+	2+	TOTAL
WEIGHT (g):																			
6.0- 6.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
7.0- 7.9	-	-	3	-	3	-	2	-	3	-	3	-	3	-	11	-	14	-	18
8.0- 8.9	1	-	3	-	4	-	4	-	3	-	4	-	4	-	15	-	19	-	35
9.0- 9.9	-	-	7	-	7	-	3	-	5	-	8	-	6	-	22	-	29	-	46
10.0-10.9	5	-	12	-	17	-	11	-	10	-	15	-	8	-	44	-	61	-	93
11.0-11.9	4	-	18	1	22	1	9	-	9	-	18	-	5	1	41	1	63	2	92
12.0-12.9	11	-	24	-	35	-	10	1	8	-	5	1	3	1	26	3	61	3	92
13.0-13.9	13	-	21	-	34	-	9	-	12	-	9	1	5	-	35	1	69	1	119
14.0-14.9	16	1	23	1	39	2	4	-	11	-	11	-	7	-	33	-	72	2	122
15.0-15.9	20	-	20	1	40	1	3	-	14	-	6	1	4	-	27	1	67	2	111
16.0-16.9	16	1	16	2	32	3	5	-	8	-	9	-	1	-	23	-	55	3	104
17.0-17.9	17	3	18	-	35	3	4	1	5	-	3	-	3	-	15	1	50	4	81
18.0-18.9	15	-	11	2	26	2	2	-	3	1	4	-	3	-	12	1	38	3	62
19.0-19.9	16	-	6	-	22	-	-	-	5	-	4	-	2	-	11	-	33	-	40
20.0-20.9	13	-	5	-	18	-	-	-	-	1	5	-	1	-	6	1	24	1	36
21.0-21.9	5	-	5	-	10	-	1	-	-	-	2	-	-	-	3	-	13	-	20
22.0-22.9	3	1	-	-	3	1	-	-	1	-	2	-	1	-	4	-	7	1	10
23.0-23.9	6	-	5	-	11	-	1	-	-	-	-	-	1	-	2	-	13	-	20
24.0-24.9	3	-	1	-	4	-	-	-	-	-	1	-	1	-	2	-	6	-	8
25.0-25.9	11	-	1	-	12	-	-	-	1	-	-	-	-	-	1	-	13	-	16
26.0-26.9	3	-	3	-	6	-	-	-	-	-	-	-	-	-	-	-	6	-	9
27.0-27.9	3	-	-	-	3	-	-	-	-	-	-	-	-	-	-	-	3	-	3
28.0-28.9	1	-	1	-	2	-	-	-	-	-	-	-	-	-	-	-	2	-	5
29.0-29.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
30.0-30.9	1	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	1	-	2
31.0-31.9	-	1	-	1	-	2	-	-	-	-	-	-	-	-	-	-	-	2	2
32.0-32.9	-	-	-	1	-	1	-	-	-	-	-	-	-	-	-	-	-	1	2
33.0-33.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
34.0-34.9	1	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	1	-	1
35.0-35.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2
36.0-36.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SAMPLE SIZE:	104	7	203	9	307	16	68	2	98	2	109	3	58	2	333	9	720	25	1160
MEAN:	17.87	19.33	15.03	19.40	16.38	19.5	12.93	14.90	13.82	19.25	13.74	14.07	13.31	11.85	13.52	14.91	15.06	17.85	15.11
STANDARD DEV	4.47	5.98	4.18	7.52	4.43	6.67	3.18	3.11	3.34	1.34	3.81	1.46	4.08	1.06	3.61	3.07	4.20	6.00	4.37
STANDARD ERR	0.33	2.26	0.29	2.51	0.22	1.67	0.39	2.20	0.34	0.95	0.36	0.84	0.54	0.75	0.20	1.02	0.15	1.02	0.12

Note: OVERALL RUN TOTAL includes samples for which ages could not be determined.

Apppendix 5 continued.

b) 1979

DATE TAGGED:	MAY 10		MAY 17		MAY 19		PREPEAK TOTAL		MAY 20		MAY 21	MAY 26	MAY 31	JUN 9	POSTPEAK TOTAL		OVERALL RUN TOTAL		
AGE:	1+	2+	1+	2+	1+	2+	1+	2+	1+	2+	1+	1+	1+	1+	1+	2+	1+	2+	TOTAL
WEIGHT (g):																			
5.0- 5.9	-	-	1	-	-	-	1	-	-	-	-	-	-	-	7	-	1	-	1
6.0- 6.9	-	-	-	-	-	-	-	-	-	-	-	1	6	-	13	-	7	-	7
7.0- 7.9	-	-	3	-	-	-	3	-	1	-	-	3	6	3	27	-	16	-	16
8.0- 8.9	2	-	6	-	3	-	11	-	3	-	-	5	11	8	40	-	38	-	39
9.0- 9.9	-	-	8	-	6	-	14	-	7	-	1	13	20	7	64	-	62	-	64
10.0-10.9	3	-	5	-	7	-	15	-	10	-	3	18	19	14	56	-	79	-	85
11.0-11.9	2	-	6	-	9	-	17	-	9	-	7	11	13	16	60	-	73	-	82
12.0-12.9	7	-	4	-	11	-	22	-	12	-	7	17	8	16	43	-	82	-	89
13.0-13.9	5	-	7	-	8	-	20	-	7	-	8	11	8	9	33	-	63	-	66
14.0-14.9	1	-	9	-	8	-	18	-	10	1	10	6	-	7	21	1	51	1	58
15.0-15.9	6	-	4	-	5	-	15	-	5	-	8	-	1	7	22	-	36	-	38
16.0-16.9	8	1	2	1	2	-	12	2	7	-	9	4	-	2	6	-	34	2	37
17.0-17.9	3	-	7	2	6	-	16	2	1	1	2	1	1	1	16	1	22	3	26
18.0-18.9	6	-	6	-	3	-	15	-	5	-	11	-	-	-	9	-	31	-	35
19.0-19.9	3	-	4	-	3	-	10	-	1	-	3	1	2	2	8	-	19	-	21
20.0-20.9	5	-	2	-	3	1	10	1	3	-	3	2	-	-	7	-	18	1	19
21.0-21.9	7	-	3	-	4	-	14	-	3	-	3	-	-	1	4	-	21	-	22
22.0-22.9	5	-	2	-	1	-	8	-	1	-	3	-	-	-	6	-	12	-	13
23.0-23.9	6	-	2	-	2	-	10	-	2	-	3	1	-	-	4	-	16	-	17
24.0-24.9	2	-	-	-	1	-	3	-	1	-	3	-	-	-	2	-	7	-	8
25.0-25.9	6	-	4	-	2	-	12	-	-	-	2	-	-	-	1	-	14	-	15
26.0-26.9	1	-	3	-	1	-	5	-	-	-	1	-	-	-	1	-	6	-	6
27.0-27.9	4	-	1	-	1	1	6	1	-	-	1	-	-	-	2	-	7	1	9
28.0-28.9	2	-	-	-	1	-	3	-	-	-	1	-	-	1	-	-	5	-	6
29.0-29.9	1	-	1	-	1	-	3	-	-	1	-	-	-	-	-	1	3	1	4
30.0-30.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
31.0-31.9	-	-	1	-	-	-	1	-	-	-	-	-	-	-	-	-	1	-	3
32.0-32.9	-	-	-	-	-	-	-	-	-	-	2	-	-	-	2	-	2	-	2
33.0-33.9	-	-	-	-	-	-	-	-	-	-	1	-	-	-	1	-	1	-	1
34.0-34.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
35.0-35.9	-	-	-	-	-	-	-	-	-	-	1	-	-	-	1	-	1	-	1
36.0-36.9	-	1	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	1	1
37.0-37.9	-	-	1	-	-	-	1	-	-	-	-	-	-	-	-	-	1	-	1
38.0-38.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
39.0-39.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
40.0-40.9	-	-	-	-	1	-	1	-	-	-	-	-	-	-	-	-	1	-	1
41.0-41.9	-	-	-	-	1	-	1	-	-	-	-	-	-	-	-	-	1	-	1
42.0-42.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
43.0-43.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
44.0-44.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
45.0-45.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
46.0-46.9	-	-	-	1	-	-	-	1	-	-	-	-	-	-	-	-	-	1	1
47.0-47.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
48.0-48.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
49.0-49.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
50.0-50.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2
57.0-57.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
76.0-76.9	-	1	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	1	1
SAMPLE SIZE:	85	3	92	4	90	2	267	9	88	3	93	94	95	94	464	3	731	12	799
MEAN:	19.01	43.20	15.88	24.45	15.85	23.85	16.86	30.57	14.02	20.37	17.56	11.90	10.46	12.34	13.23	20.37	14.56	28.02	14.96
STANDARD DEV	5.25	30.51	6.19	14.71	6.26	5.30	6.09	20.18	3.96	7.64	5.49	2.92	2.51	3.11	4.46	7.64	5.40	18.11	6.44
STANDARD ERR	0.57	17.61	0.65	7.35	0.66	3.75	0.37	6.73	0.42	4.41	0.57	0.30	0.26	0.32	0.21	4.41	0.20	5.23	0.23

Note: OVERALL RUN TOTAL includes samples for which ages could not be determined.

Appendix 6. Daily catch of adult coho at Black Creek during 1978.

DATE	STAFF GAUGE (FT)	COHO ADULT	COHO MARKED	JACK NOT MARKED	NOT CHECKED	TOTAL COHO COUNTED	COMMENT
SEP 11	2.7	18				18	MOSTLY MALES
12	2.5	13				13	
13	2.1	1				1	
14	2	0					
15	1.8	1				1	
16	1.8	0					
17	1.6						
SEP 18 to OCT 13 - no catch and gradually decreasing water levels 1.6 ft - 0.9 ft.							
OCT 14	1						
15	1						LET LEAVES BUILD UP ON
16	1						FENCE TO INCREASE DEPTH
17	1.1						
18	1.1						
19	1.2	0					
OCT 20	1.2	2		0		2	
21	1.2	45		9		54	
22	1.2	0	0	0		0	
23		346	20	25		391	PLYWOOD ON FENCE - RAINING
24		598	40	63		701	
25		157	0	28		185	NICE WEATHER - FISH POOLED UP
26		40	10	2		52	
27		19	0	8		27	PLYWOOD ON FENCE
28		22	0	0		22	GOOD RAIN
29		636	90	96		822	
30		88	10	6		104	SCHOOL OF FISH BEHIND FENCE
OCT 31		253	6	5	15	279	OPEN 11:30-2PM. 4:30-6:30PM
NOV 1		355	0	3	19	377	PANEL OPEN 3:00 PM - 6:30 PM
2		697	40	59	0	796	TO COUNT FISH THROUGH
3		588	12	7	30	637	PANEL OPEN 1:00 PM - 4:00 PM
4		101	0	0	2	103	PANEL OPEN 1:00 PM - 2:00 PM
5		96	0	1	6	103	PANEL OPEN 1:00 PM - 2:30 PM
6		908	2	5	18	933	PANEL OPEN 2:00-5:30 PM RAINING
7	3	2551	8	2	155	2716	OPEN 10:30 AM-12:00 PM, 2:00-3:30
8	3.1	41	0	0		41	PULLED PLYWOOD, LOTS OF LEAVES
9	2.9	8		2		10	
NOV 10	2.8	1		0		1	
11	2.8	0				0	SLIGHT RAIN
12	2.7						
13	2.7						
14	2.6						DRIZZLE
15	2.6						
16	2.6						COLD, DRY WEATHER
17	2.4						LETTING LEAVES BUILD UP
NOV 18 to NOV 25 no catch no staff gauge record.							WATER LEVELS CONTROLLED NOV 18
NOV 26	2.8						NOV 25
27	2.8						RAINING
28	2.7						
29	2.6	1				1	
NOV 30	2.6	1				1	SLIGHT RAIN
DEC 1 TRAP REMOVED							
TOTAL COHO		7587	238	321	245	8391	

Appendix 7. Daily catch of adult coho at Black Creek during 1979.

DATE	STAFF GAUGE (FT)	COHO ADULT MARKED	COHO ADULT NOT MARK	COHO ADULT NOT CHECK	COHO JACK MARKED	COHO JACK NOT MARK	COHO JACK NOT CHECK	TOTAL COHO CAUGHT	COMMENT
SEPT 8	1.5			3				3	TRAP INSTALLED - FIRST RAIN
SEPT 9 to OCT 17 no catch									
OCT 18	1.5			5	1		2	8	
19	1.5	1	2					3	
OCT 20									
21									
22	1.8	17	14	87	58	24		200	RUN STARTED AT 12:00 NOON
23	2.1	71	36	195	217	55		574	1 FEMALE DEAD IN FENCE
24	3.2			178	42	10		230	PANELS CLEANED 2 TIL 11 AM
25	4.4	4	2	67	36	13		122	PANELS CLEANED 12 TIL 6 PM
26	4							0	PANELS REMOVED OCT 25, 6 PM
27			1			2		3	TIL 9 AM OCT 27. PULLED AT 3 PM
28								0	PANELS INSTALLED 9:30 - 4:30 PM
29	3.2		3					3	PANELS INSTALLED 9:30 AM
30	2.8		1		1			2	
OCT 31									
NOV 1	2.4		1		1			2	
2	2.3								
3	2.3								CLOUDY SLIGHT RAIN
4	2.3								RAINED HARD AT NIGHT
5	2.5			1				1	HEAVY LEAF BUILDUP WATER UP
6	2.4								WATER SLOWLY DROPPING
7	2.4								
8	2.3								
9	2.3								SET PLYWOOD TO STOP GILLING
NOV 10	2.3								
11	2.3								WATER FLOW DROPPING
12	2.2								
13	2.2								
14	2.2								
15	2.1								SLIGHT RAIN
16	2								CLOUDY DRIZZLE
NOV 17 TO NOV 21 - no catch, water level steady at 2.1 ft.									
22	2.9	1	6	2	3	1		13	RAINED EARLY. EGG TAKE.
23	3.2			12	3	4		19	SOME RAIN FLOW DROPPING
24	2.8			3	1	1		5	FLOW DROPPING.
25	2.5			1				1	FREEZING AT NIGHT
26	2.2			1				1	SPAWNED OUT SALMON TODAY
NOV 26 TO DEC 1 - no catch									
DEC 1 trap removed									
TOTAL		94	66	555	363	110	2	1190	

Appendix 8. Daily catch of adult coho at Black Creek during 1980.

DATE	STAFF GAUGE (M)	COHO ADULT MARKED	COHO ADULT NOT MARKED	NOT CHECKED	COHO JACKS	TOTAL COHO COUNTED	COMMENT
SEP 9	TRAP INSTALLED						
SEP 10	to Oct 8 - NO CATCH						
OCT 9							APPROX. 20 ADULTS IN POOL
OCT 10							WATER TOO LOW FOR THEM
OCT 11	to 23 - NO CATCH						TO ENTER TRAP
24	0.35				9	9	
25		6	1	6	58	71	
26	0.35	6	5	2	43	56	WATER STILL LOW BUT FISH
27	0.35	70	13	118	150	351	MOVING ON HIGH TIDE
28	0.35	16	8	25	42	91	
29	0.35	1	1	17	26	45	
30	0.35	1	1	9	19	30	
OCT 31	0.5	22	6	432	215	675	RAINING STEADILY WATER UP
NOV 1	0.75			452	346	798	RAINING
2	0.9	77	52	82	132	343	
3	0.9	47	33	69	46	195	
4	0.8	19	6	136	3	164	FISH COUNTED THRU OPEN PANELS
5	0.9	1	2	7	4	14	TRAP OPEN ALL NIGHT
6	1.25						PANELS PULLED AND TRAP OPEN -
7							NOV 6 TO NOV 8
8							TRAP REPLACED MORNING OF NOV 8
9							AND OPERATED UNTIL NOV 25 WITH
NOV 10	to NOV 25 - NO CATCH						
26					2	2	
27				3	2	5	
28							NO FISH CAUGHT AFER NOV 27
29							HIGH WATER CAUSING FLOODING
NOV 30							TRAP WAS LEFT OPEN
DEC 1	TRAP INOPERABLE						
TOTAL COHO		266	128	1358	1097	2849	